

5.0 Conservation Priorities and Techniques

5.1 Conservation Targets

The evaluation and conservation rankings of alvar communities described in Chapter 2, together with information on significant species, provide a wealth of information on which to base conservation priorities. Since most conservation work is carried out at the site level, and a single site often contains several communities and significant species, conservation priorities are most effectively identified as a series of specific sites. This section presents an approach to identifying alvar sites that are most important to protect first.

A key question was considered in identifying these sites: *How many need to be protected, in order to capture the full range of alvar biodiversity within the Great Lakes ecoregion and to ensure its survival over the long term?*

As part of an ecoregional planning process to identify high-priority conservation sites in ecoregions across the Great Lakes basin, TNC and Heritage Program science staff have identified the following conservation targets:

- All natural communities within the ecoregion, regardless of rarity
- All globally significant (global rank of G1-G3G4) plant and animal species
- More common (global rank of G4-G5) species that are disjunct in the ecoregion

Regional conservation objectives have been established for each of these targets to address the question of how many occurrences of each should be protected to ensure its long-term survival in the ecoregion. For natural communities, the following draft goals and objectives are relevant to Great Lakes alvar communities:

Global Rank	Distribution Relative to Ecoregion	Rangewide Goal	Ecoregion Objective
G1-G2	endemic, limited, disjunct, or widespread	All viable occurrences (ideally, restore 30-60 occurrences, rangewide)	All viable occurrences (EO rank A-C)

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G3-G4	endemic, limited, disjunct	30-60 occurrences (depending on actual distribution across subsections)	Section-scaled replication (>3). Subsection-scaled representation
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Since most alvar communities have global ranks of G1 or G2, these objectives emphasize the importance of maintaining essentially all of the existing viable occurrences, at least up to a goal of 30 to 60 examples of each community type.

Setting objectives for species occurrences is more difficult since only a few rare or disjunct species occur exclusively on alvars within the Great Lakes basin. However, where globally rare species (G1-G3G4) occurrences are known on alvars, they are included as a criterion for identifying significant sites for protection, with the objective of protecting all known occurrences of G1 and G2 species and most of the viable occurrences of G3 and G3G4 species. Most alvar occurrences of disjunct species are thought to be included through their associated communities, but a specific objective for disjunct species was not identified.

Applying these objectives results in most of the alvar sites listed in Table 2 being included as significant sites. But within this list of sites, there are some that are relatively small, with only one or two target communities or species present, and others with a rich mosaic of target elements. Some greater definition of priority sites seemed necessary.

In keeping with the collaborative nature of the Alvar Initiative, direction was sought from a range of people on how to establish these priorities. As part of the June 1998 alvar workshop in Tobermory, speakers and participants (who included agency and NGO staff, landowners, and scientists) were asked to focus on priorities for alvar conservation. In one exercise, participants were clustered into small groups and asked: *How should we decide which sites to protect first, given limited conservation resources?*

The results from these groups were summarized and distributed for further discussion, and subsequently used as a guide to develop criteria for identifying priority sites. The weights assigned by the workshop participants were as follows:

Very High Priority:

Capture full range of alvar communities

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Protect sites with largest concentrations of rare species and communities

Protect threatened sites first

Capture full diversity of rare alvar species

Protect sites with highest overall ecological diversity

High Priority:

Protect representative alvar communities/species in each ecoregion

Protect sites where there is funding or opportunity

Focus on sites with strong lead organization and good chance for success

Moderate Priority:

Capture range of alvar landforms and geologic types

Protect largest sites

Protect areas that are clustered or connected

Start with one to three sites in each jurisdiction

Other suggestions:

Protect alvar sites connected to other environmentally significant areas

Focus on sites where value can be communicated to the public and local community

Protect sites that offer conservation leverage

Based on this list of weightings from the workshop participants, four criteria were identified to help define the most important alvar sites for immediate conservation action:

- ❑ Sites which include the largest diversity of high quality alvar community types.
- ❑ Sites which, collectively, best represent each of the alvar community types across their entire range.
- ❑ Sites which best represent the full diversity of alvar communities and associated species within each ecoregion.
- ❑ Sites which have globally rare species associated with alvar habitats.

Sites which met two or more of these criteria were identified as “alvar sites with multiple values,” highlighting a suite of sites of the highest priority. This assessment was complemented by an evaluation of the urgency of protection or management actions needed for each priority site, thereby helping to determine where conservation actions may be needed first.

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Other factors may also be considered at a state/provincial or local level in assigning priorities, and factors such as changing threats or immediate opportunities may also have a major influence on where conservation activities take place first.

5.1.1 Applying Conservation Criteria

In the following sections, individual alvar sites which meet each of these four criteria are listed, along with a brief description of how each criterion was applied. The resulting multiple-value alvar sites are listed in Section 5.1.2 and other significant sites in Section 5.1.3.

Criterion 1: Diversity of alvar community types

This criterion records the number of alvar community types with occurrences identified as conservation “Priority 1” (Table 2) that occur within each site. Only sites with three or more of these community types are included (Map O).

Criterion 2: Representing alvar community types

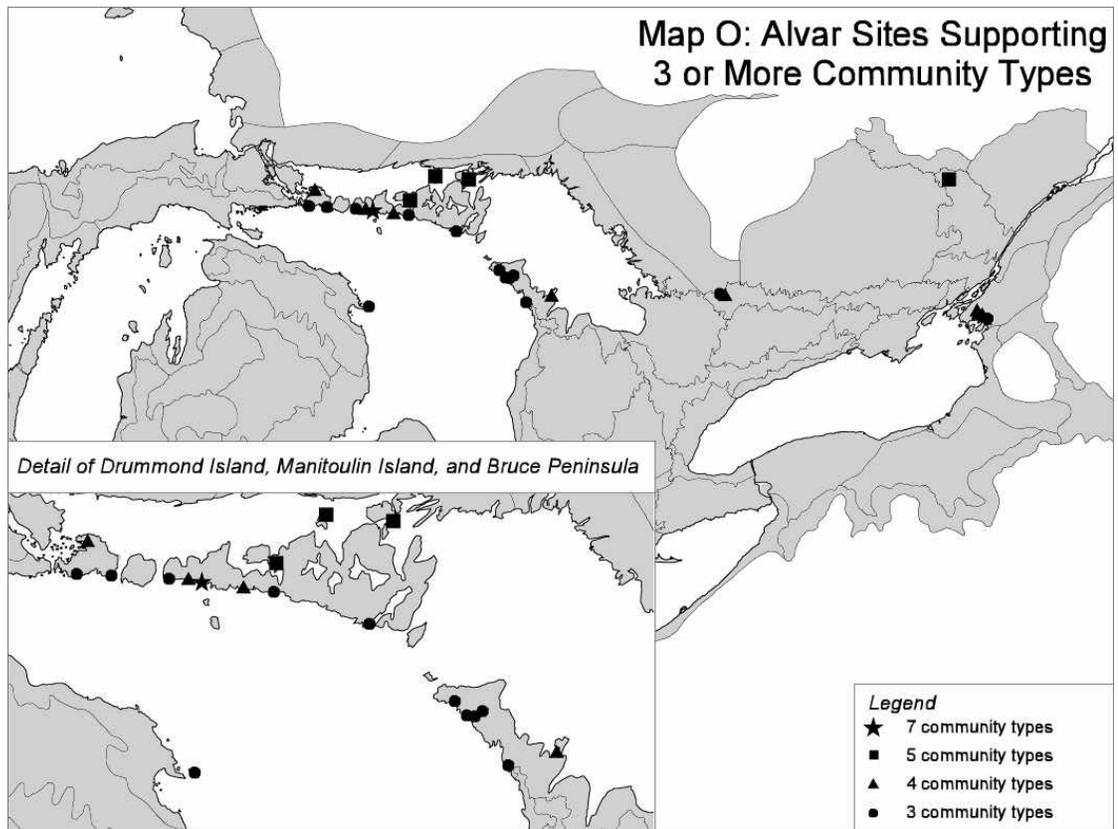
This criterion highlights those sites which best represent each of the 13 alvar community types anywhere within their Great Lakes range. (The four associated community types were not included in this analysis since they were not adequately sampled in the field to provide a reliable basis for choosing representative sites.) Up to three sites were selected for each alvar community type. Since site quality is an important factor, only communities with a condition rank of A and a landscape context rating of A or B were considered, unless only lower-quality sites were available. [*Condition rank is a measure of the degree of disturbance or maturity of each occurrence; landscape context ranks evaluate the degree of naturalness or conflict with the surrounding landscape.*] The largest examples of these high-quality communities were then selected, with consideration to distribution across the range of each alvar community type where possible (Map P).

Table 6: Alvar sites with three or more priority 1 community occurrences.

Site name	Number of community types	Site name	Number of community types
Bass Cove MI	3	Clapperton Island ON	5
Huron Bay MI	3	Dyer’s Bay/Brinkmans Crn ON	3
Maxton Plains MI	4	East Side of Quarry Bay ON	4
Thunder Bay Island MI	3	Foxy Prairie ON	5

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Site name	Number of community types	Site name	Number of community types
Chaumont Barrens NY	4	LaCloche Area ON	5
Limerick Cedars NY	3	Misery Bay ON	4
Lucky Star NY	4	Pendall Lake ON	3
Three Mile Barrens NY	4	Pike Bay ON	3
Barney Lake ON	3	Pine Tree Harbour ON	3
Belanger Bay ON	7	Strawberry Island ON	3
Burnt Lands ON	5	Taskerville ON	4
Cape Croker ON	4	West of Lynn Point ON	3
Carden #1 ON	3	West of South Baymouth ON	3
Carden #5c ON	4		



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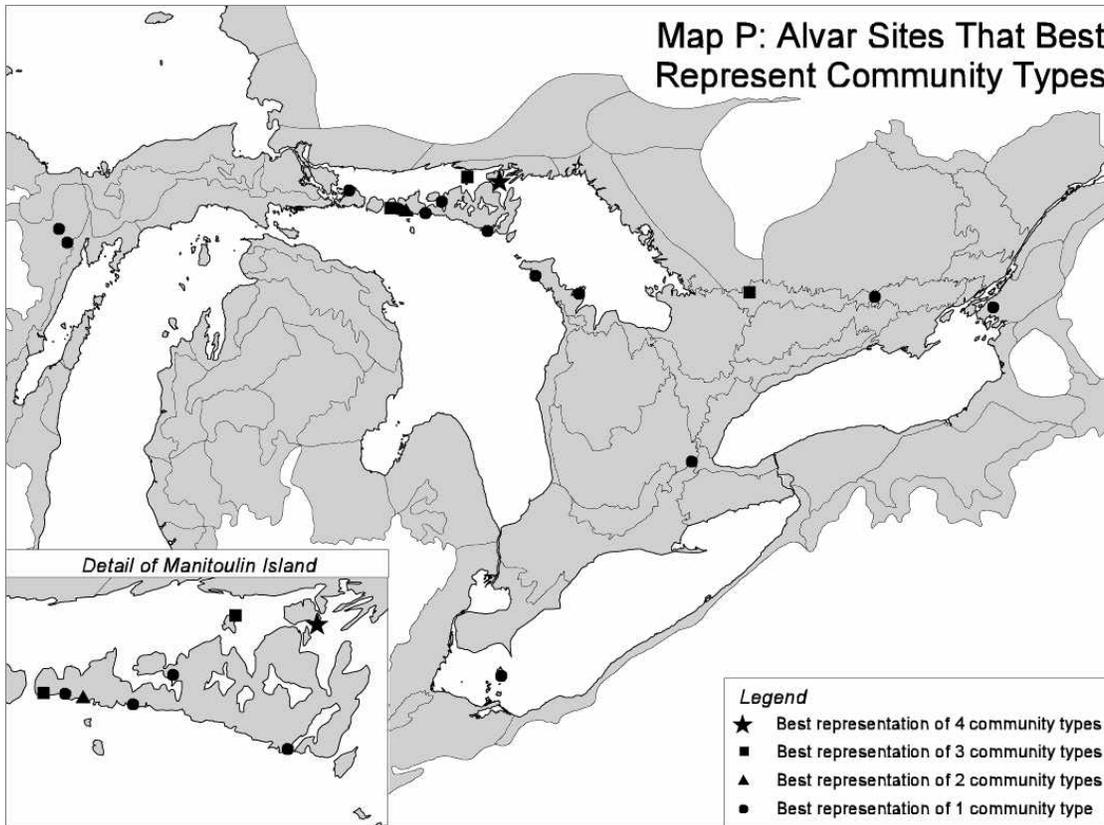


Table 7: Best representative sites for alvar community types

Tufted hairgrass wet alvar grassland	LaCloche Area ON East Side Misery Bay ON Carden #3a ON
Little bluestem alvar grassland	LaCloche Area ON Cape Croker ON Belanger Bay ON
Annual alvar pavement-grassland	LaCloche Area ON Clapperton Island ON Burnt Lands ON
Alvar nonvascular pavement	Limerick Cedars NY East Side of Quarry Bay ON Huron Bay MI
Poverty grass dry alvar grassland	Sheguiandah Bur Oak ON Carden # 5c ON Burnt Lands ON
Creeping juniper - shrubby cinquefoil alvar pavement	LaCloche Area ON Clapperton Island ON Pine Tree Harbour ON
Scrub conifer / dwarf lake iris alvar shrubland	Belanger Bay ON Garden Southeast Glade MI West of South Baymouth ON
Juniper alvar shrubland	Belanger Bay ON Cape Croker ON Maxton Plains MI
Shagbark hickory / prickly ash alvar savanna	Hayesland - Flamborough Plain ON
Chinquapin oak / nodding onion alvar savanna	Stone Road - Pelee ON

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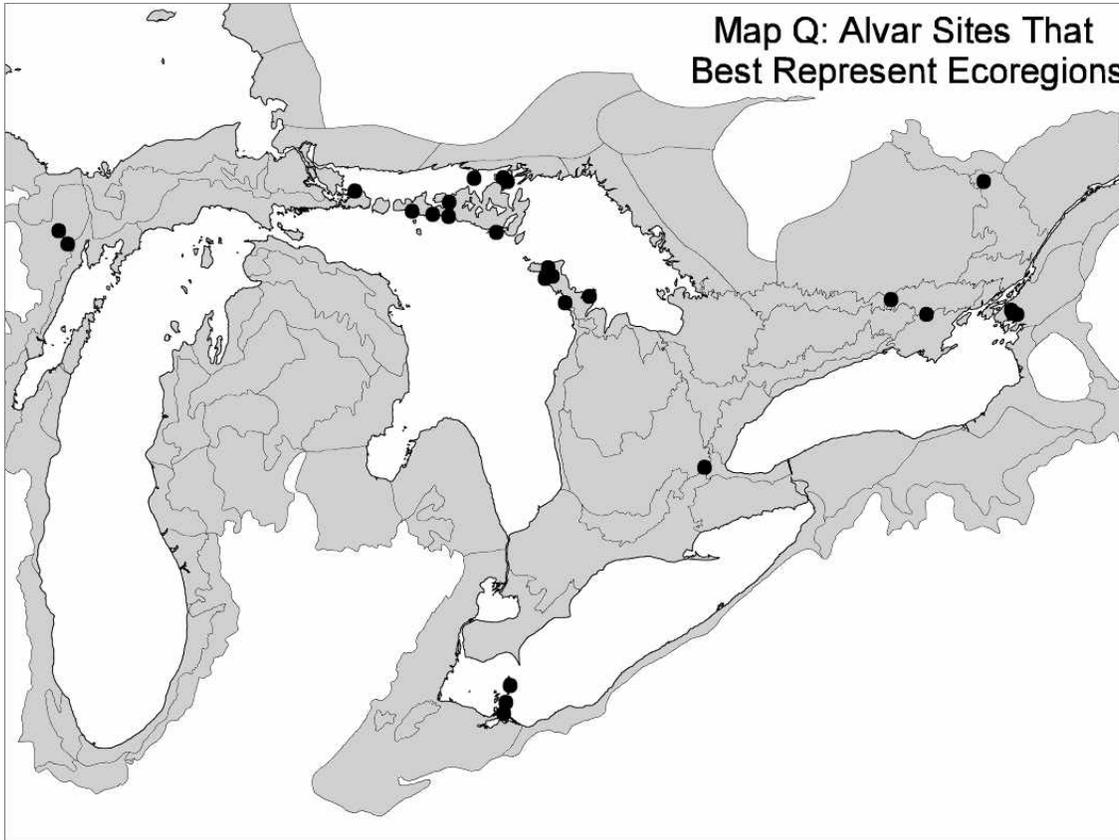
White cedar - jack pine / shrubby cinquefoil alvar savanna	Pine Tree Harbour ON George Lake ON Bass Cove MI
Mixed conifer / common juniper alvar woodland	Carden # 3a ON Pine Tree Harbour ON East Side of Quarry Bay ON
Red cedar / early buttercup alvar woodland	Salmon River ON Gretna ON Massassauga Point ON

Criterion 3: Representing diversity within ecoregions

Since the species composition and floristics of alvars vary considerably across their Great Lakes range (Catling and Brownell 1995), it is important to identify the best sites within each site district or ecoregional subsection to capture the full range of alvar diversity. This analysis was assisted by assigning biodiversity ranks to sites within each of these units, based on an approach developed by The Nature Conservancy.

Biodiversity ranks highlight outstanding or very significant sites within each site district or subsection. These sites were then examined to capture examples of all of the community types within that unit. Biodiversity rankings were assigned on the basis of all 17 alvar and associated community types, but not including species (which are

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considered separately in the next criterion). Sites meeting this criteria include all B1 sites, or otherwise sites of the best available quality within each eco-unit, to represent the range of alvar and associated community types occurring there. Where possible, two or three good-quality examples of each type are included to provide replication (Map Q).

Definition of Biodiversity Ranks

- B1: Outstanding significance, such as the only known occurrence of any element, the best or an excellent (A-ranked) occurrence of a G1 element, or a concentration (4+) of high-ranked (A- or B-ranked) occurrences of G1 or G2 elements. Site should be viable and defensible for targeted elements and ecological processes contained.

- B2: Very high significance, such as one of the most outstanding occurrences of any community element (regardless of its element rank). Also includes areas containing any other (B-, C-, or D-ranked) occurrence of a G1 element, a good (A- or B-ranked) occurrence of a G2 element, an excellent (A-ranked) occurrence of a G3 element, or a concentration (4+) of B-ranked G3 or C-ranked G2 elements.

Conserving Great Lakes Alvars

Table 8: Representative alvar sites within each site district/subsection

Ecoregional Unit	Alvar Community Types Present (type #'s from Table 1)	Representative Sites and Their Biodiversity Ranks
Site District 5E2 ON	North Shore: 2,3,4,5,7 South Shore: 2,3,4,5,6,7,8,9,12,13,16	Belanger Bay - B1 Clapperton Island - B1 East Side of Quarry Bay - B1 Foxy Prairie - B1 Misery Bay - B1 West of South Baymouth - B1
Site District 5E3 ON	2,3,4,5,8,14/15	LaCloche Area - B1
Site District 6E1 ON	10	Hayesland (Flamborough Plain) - B3
Site District 6E4 ON	3,5,14/15	Pike Bay - B1
Site District 6E9 ON	Carden Plain: 2,3,5,8,13,16 Dummer Moraine: 4,8,13 Napaneer Plain: 13	Bend Bay Valley - B2 Carden # 5c - B2 Carden # 3a - B2 Carden #1 - B2 Cameron Ranch - B2 Camden East - B2?
Site District 6E11 ON	2,4,7,8,13	Burnt Lands - B1
Site District 6E14 ON	2,3,5,6,7,8,14/15	Scugog Lake - B1 George Lake - B1 Dyer's Bay/Brinkman's Corners - B1 Pendall Lake - B1 Pine Tree Harbour - B1 Cape Croker - B2
Site District 6E15 ON	2,4,17	Gretna - B2 Howe's Road - B2 Salmon River - B3
Site District 7E1 ON	11	Stone Road - B2
Subsection 212Ee NY	2,4,7,8,16	Chaumont Barrens - B2 Three Mile Creek Road Barrens - B2 Limerick Cedars - B2 Lucky Star - B2
Subsection 212Hb MI	1,3	Escanaba River North - B2
Subsection 212Hd WI	8	State Highway 57 Expansion Project - B4
Subsection 212He MI	1,3,5,6,9	Garden Southeast Glade - B1 Sucker Lake - B1 Summer Island East Shore - B2 Escanaba River South - B2
Subsection 212Hj MI	2,3,5,7,8,9,13,14/15	Bass Cove - B1 Huron Bay - B2 Maxton Plains - B2 Jones Lake - Drummond Island - B2
Subsection 212Hi MI	2,3,6,7,9	Thompsons Harbor Observatory Point - B1 Thunder Bay Island - B2
Subsection 221Ie NY	8,9,13	Stony Point Barrens - B3
Subsection 221If OH	7,8,9	Kelley's Island North Quarry - B3 Kelley's Island North Shore - B2 Marblehead Quarry - B3

Conserving Great Lakes Alvars

- B3: High significance, such as any other (C- or D-ranked) occurrence of a G2 element, a B-ranked occurrence of a G3 element, an A-ranked occurrence of any community, or a concentration (4+) of A- or B-ranked occurrences of (G4 or G5) S1 elements.
- B4: Moderate significance, such as a C-ranked occurrence of a G3 element, a B-ranked occurrence of any community, an A- or B-ranked or only state (but at least C-ranked) occurrence of a (G4 or G5) S1 element, an A-ranked occurrence of an S2 element, or a concentration (4+) of good (B-ranked) S2 or excellent (A-ranked) S3 elements.

Within two of the Ontario site districts, Brownell (1998) has suggested that variations in bedrock type and climate warrant a further subdivision for the purposes of providing full representation of alvar types. In selecting representative sites for site districts 5E2 and 6E9, Brownell's subdivisions have been considered – northern and southern Manitoulin Island within 5E2, and Carden Plain, Dummer Moraine, and Napanee Plain within 6E9.

Criterion 4: Rare species associated with alvar habitats

Some alvar sites shelter globally rare species, which add to their conservation value. The listing of species is inevitably incomplete due to uneven field inventories and the lack of global rankings for many invertebrate species. Additional data on vertebrate and invertebrate species and nonvascular plants should be added to this analysis as data becomes available.

Known occurrences of plant or animal species are summarized for each site in the following table, including species with global rankings of G1, G2, G3, G3G4, G3G5, or T3 (for a rare subspecies or variety). To qualify under this criterion for the multiple-value table, sites could have one or more G1 or G2 species, or two or more species ranked G3 or below.

Species which are rare at the state or provincial level (S1-S3 ranked species) also add to the significance of individual alvar sites, and this aspect should be incorporated into evaluations at that level. In fact, some alvar sites have an exceptional roster of species that are rare within their jurisdictions - Stone Road alvar, for example, has at least 48 species that are rare in Ontario. However, S-ranks for individual species can vary widely across the Great Lakes basin, and it is difficult to incorporate a meaningful analysis of state/provincial rarity at this level. For that reason, only globally ranked rare species are considered under this criterion.

Conserving Great Lakes Alvars

Species diversity is another valid measure contributing to the significance of a site. However, given the disparity in degree of effort and expertise involved in surveying such a large set of alvar sites, the potential differences related to site location and type, and the difficulty in assembling comprehensive species lists for each site, this measure did not appear feasible at the Great Lakes basin scale. In future studies, especially at the state/provincial level, measures of total native plant or insect group diversity, or of diversity of species highly confined to alvars, could be useful indicators of site quality.

Table 9: Alvar sites with known occurrences of globally rare species

Site	Number of Species with Global Rank					
	G1	G1G2	G2	G2G3	G3	G3G4/G3G5/T3
Big Shoal Cove MI		1 invert.				
Bass Cove MI					1 plant	
Charboneau Lake MI					1 plant	
Escanaba River South MI					1 plant	
Garden Southeast Glade MI					1 plant	
Goudreau's Harbor MI			1 invert.		1 plant	
Grand Lake MI					1 plant	
Huron Bay Road MI					1 plant	
Jones Lake - Drummond Is. MI					1 plant	
Kregg Bay Glade MI					1 plant	
Kregg Bay N.E. MI					1 plant	
Maxton Plains MI					1 plant	
Point Detour MI					1 plant	
Poverty Island E.S. MI					1 plant	
Seaman's Point MI					1 plant	
Sucker Lake MI					1 plant	
The Rock MI					1 plant	
Thompson's Harbor MI					1 plant	
Burnt Rock Barrens NY					1 plant	
Chaumont Barrens NY					1 plant	1 plant, 1 non-vasc
Limerick Cedars NY					2 plants	1 plant, 1 non-vasc, 1 bird

Conserving Great Lakes Alvars

Site	Number of Species with Global Rank					
	G1	G1G2	G2	G2G3	G3	G3G4/G3G5/T3
Kelley's Island Central Quarry OH			1 plant			
Marblehead Quarry OH			1 plant			
State Hwy 57 WI					1 plant	
Asselstine ON						1 bird
Baptist Harbour ON					1 plant	1 non-vasc
Barney Lake ON					1 plant	
Bear's Rump Island ON						1 non-vasc
Belanger Bay ON		2 inverts.	1 plant		3 plants 1 invert	
Burnt Lands ON	2 invert.		2 invert.	1 invert.	2 invert. 1 plant	
Cabot Head ON			1 plant			1 non-vasc
Cameron Ranch ON						1 bird
Cape Croker ON			1 plant			1 plant, 1 reptile
Carden # 5c ON						1 bird
Chief's Point ON					2 plants	
Christina Bay/Burnt Island Hbr ON			1 plant		1 plant 1 invert.	
Claybank ON					1 invert.	
Driftwood Cove ON					1 plant	
Dyer's Bay Rd/Brinkman's Cnr ON			1 plant	1 invert.	1 plant	1 non-vasc, 1 rept.
East Side of Quarry Bay ON		1 invert.	1 plant		1 plant	
Evansville ON				1 invert.	1 plant 1 invert.	
George Lake ON			1 plant			1 reptile
Greene Island ON			1 plant			
LaCloche Area ON		1 invert.			3 plants	1 plant
Misery Bay ON		2 invert.	1 plant		2 plants	1 non-vasc
Niibin ON						1 non-vasc
Pendall Lake ON		1 invert.			1 invert.	1 reptile
Pike Bay ON					2 plants	1 reptile
Pine Tree Harbour ON					1 plant	1 reptile

Conserving Great Lakes Alvars

Site	Number of Species with Global Rank					
	G1	G1G2	G2	G2G3	G3	G3G4/G3G5/T3
Point Anne ON				1 invert.		
Salmon River ON			1 plant		2 invert.	
Scugog Lake ON		1 invert.		1 invert.	1 plant 1 invert.	1 reptile
Sideroad Creek ON					1 plant	1 non-vasc, 1 rept.
Silverwater Radio Towers ON			1 plant			
Stone Road ON					1 reptile	2 plants
Stony Swamp				2 invert.		
Strawberry Island ON					1 plant	
Tamarack Harbour ON					1 plant	1 non-vasc
Taskerville ON			1 plant		1 plant	1 non-vasc
West of Lynn Point ON		1 invert.	1 plant	1 invert.	1 plant	
West of South Baymouth ON		1 invert.	1 plant		1 plant 1 invert.	

5.1.2 Great Lakes Alvar Sites with Multiple Values

Alvar sites which meet more than one of the four criteria are listed in the following table and shown on Map R. Only eight sites met all four of the criteria. Four sites – LaCloche Area Alvar, Belanger Bay Alvar, Burnt Lands Alvar, and East Side of Quarry Bay Alvar – can be considered outstanding priorities since they provide the best representation of several community types while also meeting the other criteria. All four of these sites have very high protection urgency ratings.

This summary chart also highlights the importance of Manitoulin Island as a whole as the epicenter of significant alvars within the Great Lakes basin. Over one-quarter of the alvar sites with multiple values occur on Manitoulin Island.

The fifth and sixth columns, dealing with protection urgency, provide an assessment of the degree of immediate threat to each of these multiple-value sites. This assessment is based on a threats analysis for each site carried out by a local collaborator familiar with the site. Protection urgency has been subdivided into two categories - securement and management.

Conserving Great Lakes Alvars

Securement urgency is the need for short-term actions to secure the land base within the alvar in some form of protective ownership. For example, a site which is currently for sale or has been zoned for aggregate operations would receive a VH (very high) securement urgency rating. On the other hand, sites such as Scugog Lake and Chaumont Barrens, where major parts of the alvars are in protective ownership, would be rated as M (moderate) or L (low). Sites in private ownership where major landowners are known to be sympathetic to conservation would also receive a relatively low ranking for securement urgency.

The management urgency rank relates to threats which are independent of land ownership, such as invasion of exotic species or changes in hydrology. Depending on the scope, severity, and immediacy of the threat, sites are ranked from very high to low management urgency.

In general, sites which are known to be at immediate risk because of impending development or ongoing stresses should be considered more urgent priorities as protection targets.

Table 10: Alvar sites with multiple values

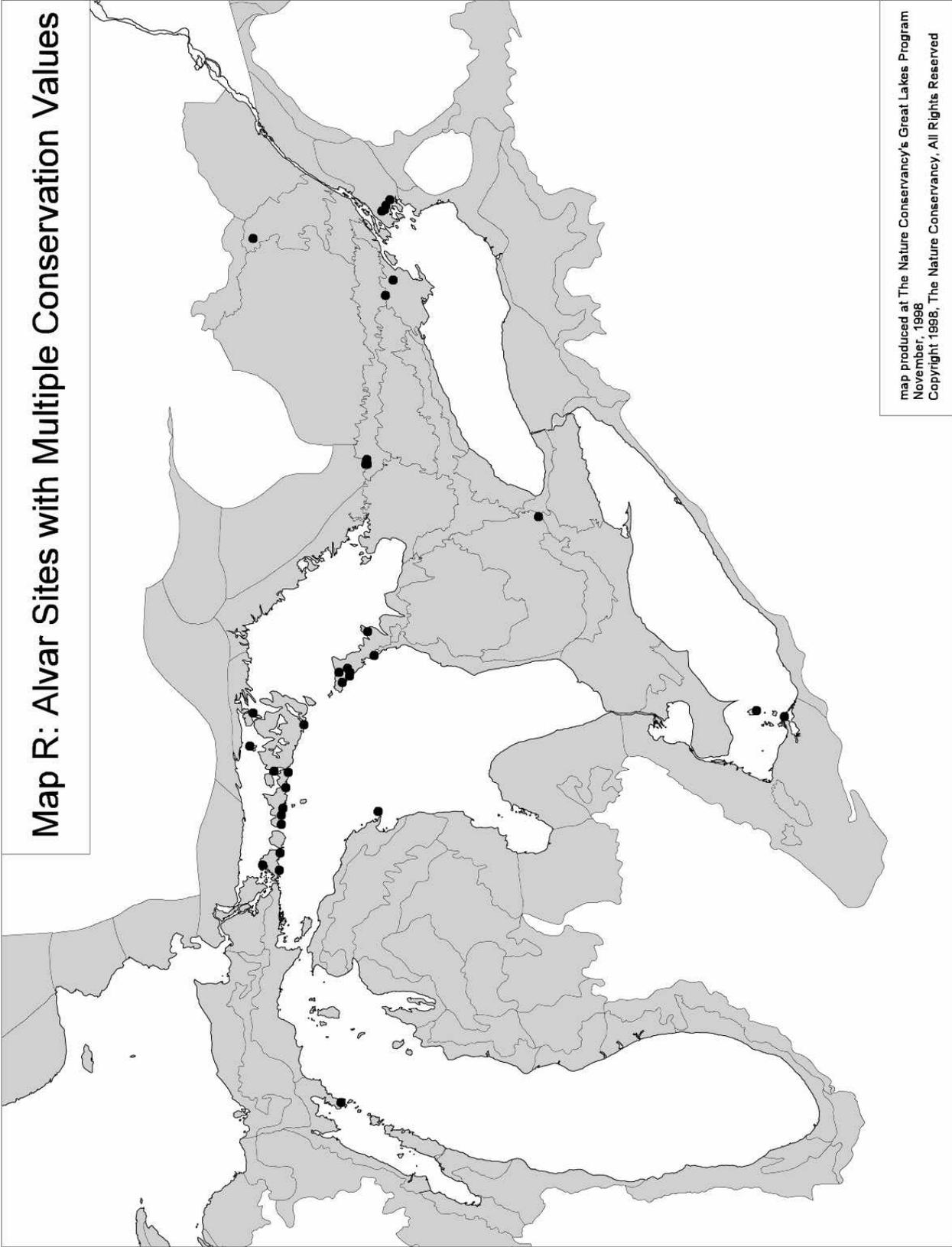
Site Name	# of community types (3 or more)	Best community representation	Best ecoregional representation	Globally rare species	Securement urgency	Management urgency
<i>Michigan</i>						
Bass Cove	3	,	,	,	VH	M
Garden SE Glade		,	,		H	L
Huron Bay	3	,	,		VH	M
Maxton Plains	4	,	,		H	H
Thunder Bay Island	3		,		L	L
<i>New York</i>						
Chaumont Barrens	4		,	,	L	VH
Limerick Cedars	3	,	,	,	H	VH
Lucky Star	4		,		VH	VH
Three Mile Barrens	4		,		VH	VH
<i>Ohio</i>						
Marblehead (Lakeside)			,	,	VH	M

Conserving Great Lakes Alvars

Site Name	# of community types (3 or more)	Best community representation	Best ecoregional representation	Globally rare species	Securement urgency	Management urgency
<i>Ontario</i>						
Belanger Bay	7	3 types	,	,	VH	H
Burnt Lands	5	2 types	,	,	VH	H
Cape Croker	4	,	,	,	L	H
Carden # 1	3		,		H	M
Carden # 3a		2 types	,		H	H
Carden # 5c	4	,	,		VH	M
Clapperton Island	5	2 types	,		L	M
Dyers Bay/Brkmns Cnr	3		,	,	L	H
East Side Quarry Bay	4	2 types	,	,	VH	L
Foxy Prairie	5		,		M	VH
George Lake		,	,	,	L	M
Gretna		,	,		L	H
Hayesland - Flamb.		,	,		M	H
LaCloche Area	5	4 types	,	,	VH	VH
Misery Bay	4		,	,	VH	H
Pendall Lake	3		,	,	L	L
Pike Bay	3		,	,	M	M
Pine Tree Harbour	3	3 types	,	,	L	L
Salmon River		,	,	,	VH	H
Scugog Lake	3		,	,	L	H
Stone Road		,	,	,	L	H
Taskerville	3			,	L	L
West of Lynn Point	3			,	H	L
West of South Baymouth	3	,	,	,	VH	L

Conserving Great Lakes Alvars

Map R: Alvar Sites with Multiple Conservation Values



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Conserving Great Lakes Alvars

5.1.3 Other Significant Alvar Sites

In addition to the multiple-value sites listed above, other alvar sites across the Great Lakes basin are worthy of conservation. The following sites include one or more alvar communities with a conservation priority rank of 1 (see Table 2) or have good populations of significant species. These sites are considered viable and add significantly to the long-term conservation of biodiversity within the basin.

Other significant Michigan sites:

Charboneau Lake	Kregg Bay Glade
Goudreau's Harbor	Point Detour
Escanaba River North	Seaman's Point
Escanaba River South	Sucker Lake
Grand Lake	Summer Island East Shore
Jones Lake-Drummond Island	Thompsons Harbor
	Observatory Point

Other significant New York sites:

Stony Point Barrens

Other significant Ohio sites:

Kelley's Island North Shore
Lakeside Daisy Nature Reserve

Other significant Wisconsin sites:

State Highway 57 Expansion Project

Other significant Ontario sites:

Manitoulin:

Creasor Blight	Rozel's Bay
Dominion Point	Sheguiandah Bur Oak
East Side Misery Bay	Strawberry Island
Evansville Shrubland	Tamarack Harbour
Greene Island	Vidal Island
Northwest & Big Burnt Islands	

Bruce Peninsula:

Baptist Harbour	Cabot Head
Barney Lake	Chief's Point
Barrier Island	Driftwood Cove
Bear's Rump Island	Fishing Islands

Conserving Great Lakes Alvars

Niibin
Sideroad Creek

St. Jean's Point

Carden Plain:

Cameron Ranch
Carden Alvar #4

Carden Alvar #2

Eastern Ontario:

Bend Bay Valley
Camden East
Clay Bank
Howe's Road

Massassauga Point
Point Anne

5.1.4 Attainment of Ecoregional Goals

As outlined earlier in Section 5.1, goals and objectives for alvar communities in the Great Lakes basin call for all viable occurrences of most community types to be protected, and a total of 30 to 60 representative occurrences across the region for the G3 communities. The roster of multiple-value and other significant alvar sites identified through the Alvar Initiative contributes directly to meeting these objectives. The viability of each occurrence was evaluated through its EO ranking, and priority sites were selected partially on representation criteria. Figures H and I summarize the number and acreage of viable occurrences for each alvar community type.

The contributions of these alvar sites to the globally significant and disjunct species objectives are more difficult to assess since few of these species are restricted totally to alvar habitats within the Great Lakes basin. Nearly all of the alvar sites with known occurrences of globally rare or disjunct species in the groups examined have been included on the list of significant alvar sites, with the exception of a few occurrences of G3 species on very small or degraded sites. For a few species, such as Lakeside Daisy (*Hymenoxys herbacea*) or the beetle *Chlaenius p. purpuricollis*, these alvar sites likely represent nearly all of their occurrences within the Great Lakes basin. However, most other species are not entirely confined to alvar habitats within the ecoregion, so a broader assessment of their occurrence would be needed to assess how best to meet regional conservation objectives.

5.2 Rangewide Analysis of Threats

Across their Great Lakes range, alvar habitats face a daunting series of threats to their future survival and quality. The protection urgency rankings for multiple-value alvar sites, for example, place 56% of the sites with a high

Conserving Great Lakes Alvars

or very high securement urgency, and 53% with a high or very high management urgency (see Table 10). While the nature and extent of these threats tend to be site-specific and constantly changing, a number of common factors emerge.

Conserving Great Lakes Alvars

Figure H: Abundance of alvar communities in the Great Lakes region

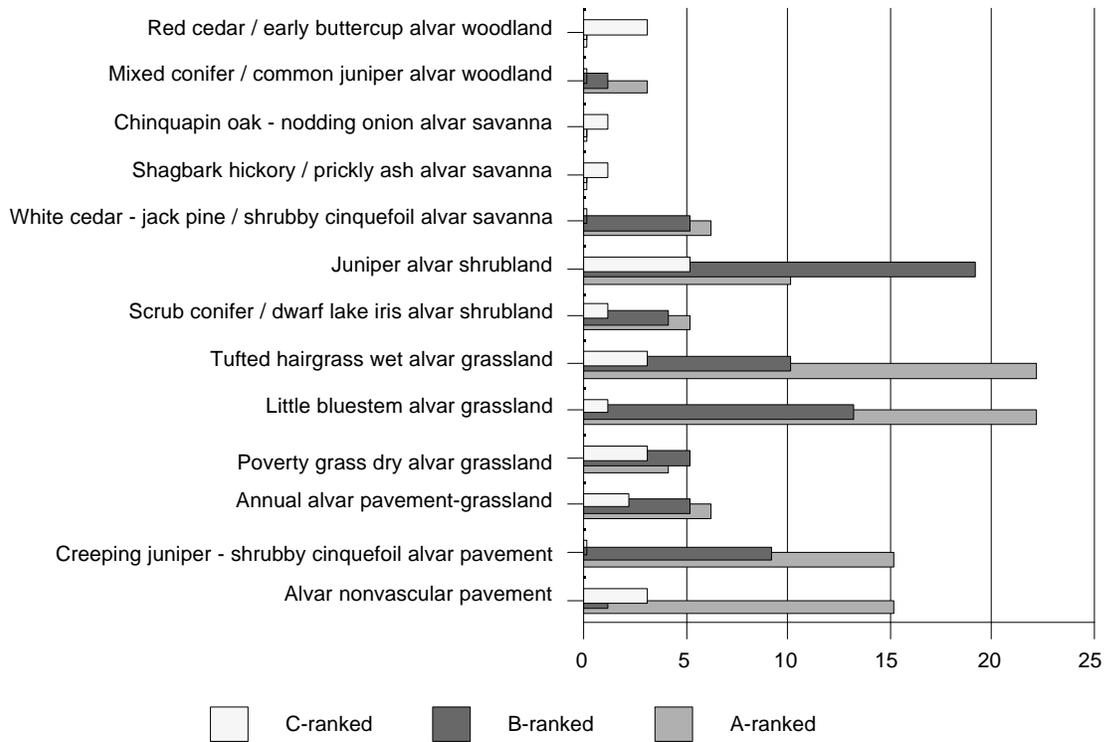
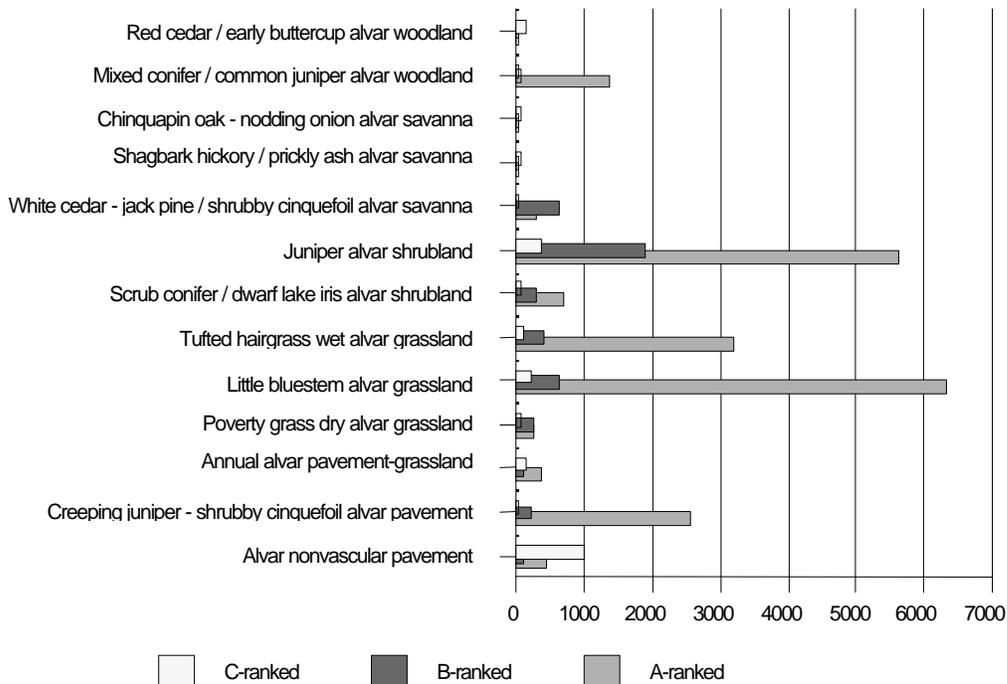


Figure I: Acreage of alvar communities in the Great Lakes Region



Conserving Great Lakes Alvars

Quarrying

The loss of alvar habitats to quarries has taken place across the Great Lakes basin and continues to be a primary threat in many places. Since quarry companies seek areas of easily accessible limestone with little overburden for economic reasons, almost any alvar area within trucking distance of major urban markets is at risk. Past quarrying activities have removed alvar habitats in places such as the Marblehead Peninsula, Carden Plain, Flamborough Plain, Point Anne on the Napanee Plain, and parts of the LaCloche area. Belanger Bay on Manitoulin Island is licensed for future massive quarrying, although no extraction has occurred there yet.

A variation of quarrying which has had very destructive effects is the commercial collection of glacial erratic boulders from the surface of the LaCloche Area alvar for sale to landscaping contractors. This activity, carried out over extensive areas during wet conditions with heavy machinery, has caused massive rutting and disturbance of the shallow alvar soil surface, and in many places, has completely destroyed the alvar. Similar collecting of limestone surface rubble and slabs for sale as flagstone has taken place at a few other alvar sites.

Residential and related development

The construction of rural residences, cottages and second homes, trailer parks, and other forms of low-density rural development is an ongoing threat to many alvar habitats in such areas as the Bruce Peninsula, Burnt Lands and other eastern Ontario alvars, New York State alvars, Michigan's Garden Peninsula, and some Manitoulin alvars including Strawberry Island and Misery Bay.

Shoreline alvars are especially at risk. Cottage development has been proposed within several significant alvar sites along the south shore of Manitoulin Island, and scattered residential development continues in many other areas. As well as the habitat removed by the construction of a house itself, larger areas are lost under fill imported for septic beds, driveways, outbuildings, and lawns. Adjacent areas may also be damaged by rutting or disturbance during construction.

A diverse mix of other rural developments can be located on alvar habitats. The Salmon River alvar has been impacted by a large commercial racetrack. Golf courses have been proposed or developed in some areas. Utility corridors also affect some alvar sites.

All-terrain vehicle and off-road vehicle use

Recreational users of all-terrain vehicles, trail bikes, and off-road trucks are attracted to some alvar areas because of their flat open terrain and

Conserving Great Lakes Alvars

remoteness. The rutting caused by these vehicles disrupts local hydrological patterns, creates conditions suitable for the invasion by exotic species and visually scars the alvar surface. Because many people don't recognize the special nature of alvar habitats and simply see them as easy places to drive over, these areas are often impacted negatively by hunters or other outdoor users.

ATV use is a particular problem within the Burnt Lands alvar, other eastern Ontario sites, several Manitoulin Island sites including Belanger Bay, Misery Bay, and Tamarack Harbour, northern New York sites including Three Mile Creek Barrens and Lucky Star, and in parts of Maxton Plains in Michigan. However, uncontrolled off-road use can quickly develop into a management challenge on almost any alvar site.

Snowmobiles are also used on many alvar sites, but their impact appears to be substantially less, or at least less documented.

At several sites in New York state, impacts are noted from the creation and maintenance of fire control roads and trails, which often create rutting. In addition, nearby municipal roads create hydrological changes and corridors of deeper soil for the invasion of exotic plants both at these New York sites and at Maxton Plains.

Grazing and browsing

Many grassland alvars, such as some of those on Manitoulin Island, Carden Plain, and in eastern Ontario, have been grazed by cattle for decades. In some areas, grazing has ceased in recent years, and the composition of alvar communities appears to be gradually changing as shrubs and trees recolonize. On other sites, cattle grazing is ongoing or being replaced by horse pasturing.

The degree of threat posed by grazing to alvar quality is discussed in Chapter 4 and is the subject of ongoing research. While intensive grazing appears to be associated with the loss of some alvar species and an increased presence of exotic species, light grazing helps to maintain the open character of some alvars. For some alvar-related fauna such as loggerhead shrike (*Lanius ludovicianus migrans*), grazing to maintain short grass conditions appears to be an essential habitat requirement for nesting.

Deer browsing is also an important factor in most Great Lakes alvar sites. High deer densities may be preventing successful regeneration of some alvar species, but the longer-term effects on community composition is uncertain at this stage. Ongoing research studies should help to clarify the nature and extent of this stress.

Conserving Great Lakes Alvars

Exotic species

Virtually all Great Lakes alvars include a diverse mix of exotic species in their flora and fauna, but the extent and trends of non-native species populations vary widely. As noted in the discussion of exotic species in Chapter 4, aggressive species which are problematic include buckthorn (*Rhamnus cathartica*), common St. John's wort (*Hypericum perforatum*), rough-fruited cinquefoil (*Potentilla recta*), and many others. Canada blue grass (*Poa compressa*), which is considered by most experts to be an introduced species, is also well established on many alvar sites. These exotic species compete for space and nutrients with native species and, in some cases, become dominant, significantly reducing the ecological value of alvar communities.

New York state alvars appear to have particularly serious problems with aggressive exotic species, but many other savanna, woodland, and grassland alvars are also noted as weedy.

Plant collecting

The extent of plant collecting on alvars by hobbyists is unknown, but the removal of stunted old-growth cedars and other trees by bonsai collectors is a serious management problem on the Bruce Peninsula. Other showy wildflowers of alvars or associated limestone woodlands, such as dwarf lake iris (*Iris lacustris*) and several orchid species, are also at risk from collectors or from careless photographers who trample surrounding vegetation. On the Stone Road alvar on Pelee Island, commercial collection of hop trees (*Humulus lupulus*) and gray-headed coneflowers (*Ratibida pinnata*) also takes place and is difficult to control.

Logging and forestry

Logging of mature trees from alvar savannas and adjacent woodlands can disrupt the landscape integrity of alvar sites. In some instances, the flat open areas provided by alvars have been used as log assembly areas or skidways, resulting in serious damage to shallow soils and vegetation communities from rutting and accumulation of bark and other debris. Very heavy uncontrolled logging has been a recent problem in parts of the Carden Plain alvars and is likely to be an issue periodically on most private land holdings that contain alvars.

A related issue is the inappropriate planting of alvar sites with trees designed to provide a future commercial crop. The most striking example of this is a jack pine plantation on part of the Burnt Lands alvar. Whether these trees are removed as part of site restoration efforts, or left in place to avoid disturbing the resident populations of rare molluscs, is an issue that will have to be addressed through a site management plan.

Conserving Great Lakes Alvars

Waste dumping and vandalism

Many alvar sites are lightly settled, and remote roadsides provide access for dumping of household garbage, construction debris, or yard wastes. In addition to smothering small areas of alvar and being a visual eyesore, some of these materials may contain toxins that leach into local groundwater, such as lead from car batteries. At one alvar site, dust from adjacent coal piles is a problem, and quarry dust is often present at some other alvar sites.

In a few places, landowners appear to have engaged in acts of ecological vandalism for no apparent reason. For example, at least one landowner has simply scraped clean an area of alvar with his bulldozer. The threat of this kind of random destruction may be partially countered by building better awareness of alvar values among landowners, but there will always likely be some residue of vandalism on both publicly and privately owned alvar sites.

5.3 Conservation Activities Underway

At least seven different types of conservation activities for alvar habitats are currently underway across the Great Lakes basin.

1. Protective public ownership

National, provincial, state, and regional government agencies all own some areas of high-quality alvar habitat in scattered sites across the basin. The Bruce Peninsula National Park incorporates several significant alvar sites, as do nearby provincial Nature Reserves. The Misery Bay Nature Reserve on Manitoulin Island incorporates a small but significant part of the Misery Bay alvar site, and parts of Burnt Lands alvar are currently proposed as a new Provincial Nature Reserve. Kelley's Island includes alvar areas within an Ohio State park, and parts of Maxton Plain are within Michigan State Forest. The Essex Region Conservation Authority owns part of Stone Road alvar on Pelee Island.

2. Protective NGO ownership

In recent years, non-government organizations have been active in acquiring significant alvar areas as part of their nature reserve systems. The Nature Conservancy has been especially active, with large alvar holdings at Chaumont Barrens and Limerick Cedars in New York state and at Maxton Plains on Drummond Island in Michigan. The Federation of Ontario Naturalists (FON) has also acquired alvar habitats as nature reserves on Pelee Island and the Bruce Peninsula.

3. Private land stewardship

Conserving Great Lakes Alvars

Several non-profit organizations have worked cooperatively with private landowners to educate them about the values of alvar habitats and to encourage voluntary conservation. The Couchiching Conservancy has worked extensively with landowners on the Carden Plain and has enlisted the support and cooperation of the owners of several thousand acres of alvar. They are also negotiating a conservation easement and a future land donation. FON has sponsored similar landowner contact programs on parts of the Bruce Peninsula and Manitoulin Island. Landowner contact materials have also been prepared for alvars on the Napanee Plain, Bruce Peninsula, and Burnt Lands.

TNC staff in New York state have initiated contact with private landowners in Three Mile Creek Barrens alvar site, and TNC has also been active in community-based work around alvars and other habitats in northern Michigan.

In total, these projects have delivered direct contact and education to over 50 landowners, with total alvar landholdings of over 17,000 acres (7000 ha).

In Ohio, a cooperative project with Lafarge, a major quarry company, has resulted in preservation of several acres of high-value alvar pavement and in colonization of former quarry areas by lakeside daisy (*Hymenoxis herbacea*) through experimental plantings.

4. Joint planning for protection

In several places, different groups have come together to jointly plan and undertake conservation programs for clusters of alvar sites. The most prominent example of this is a joint undertaking on Manitoulin Island among TNC, Nature Conservancy of Canada (NCC), FON, and the Ontario Ministry of Natural Resources (OMNR). These groups sponsored an evaluation of priority alvar habitats for acquisition, particularly within a large tract of corporate land currently for sale. If they are successful in persuading the company to accept their offer, a coordinated fundraising effort to secure the necessary support will ensue.

Similar arrangements at a smaller scale are being discussed for a project area on the Carden Plain among the Couchiching Conservancy, NCC, and OMNR.

Collectively, protection projects for alvar habitats now in the planning or implementation stages involve some 8700 acres (3580 ha) across the Great Lakes basin.

At a broader scale, TNC is currently sponsoring ecoregional studies within ecoregions in the U.S. portion of the Great Lakes basin. This process, which

Conserving Great Lakes Alvars

involves multiple local partners in workshops to jointly evaluate conservation priorities and strategies, includes consideration of alvar habitats. Ecoregional planning will likely be undertaken for parts of the Canadian side of the basin as well in the near future.

5. Integration into the planning system

In Ontario, sites identified as Areas of Natural and Scientific Interest (ANSIs) receive a degree of protection through the municipal and provincial land use planning processes. Some alvar sites have previously been identified as provincially significant ANSI's, including parts of:

Burnt Lands	Cabot Head
Camden East	Pine Tree Harbour
Salmon River	Scugog Lake
Bend Bay Valley	Dyer's Bay/Brinkman's Corners
Carden #1	Fishing Islands
Stone Road	Bear's Rump Island
Cape Croker	

However, most other alvars have not yet been considered by the program. The FON has retained an experienced consultant to carry out an alvar theme study that will result in the identification of these ANSIs on a representative basis across southern Ontario. When this study has been reviewed and endorsed by the Ministry of Natural Resources, it should provide a basis for improved integration of selected sites into the land use planning system. In addition, private owners of ANSI areas qualify for an exemption of their property taxes under the Conservation Lands Tax Incentive Program as an incentive to retain the natural values of their lands.

At a regional level, priority alvars identified by the Couchiching Conservancy are being incorporated into the Victoria County Official Plan with policies to discourage future development within these areas. The same process has taken place in some eastern Ontario municipalities and will be encouraged elsewhere as well.

6. Site management and restoration

Relatively little work has been carried out on alvar site management and restoration, but a few good examples do exist. TNC preserves at both Chaumont Barrens and Maxton Plains have been used as study sites for a range of research projects, including experimental treatments of non-native plants to evaluate control options. As well, interpretive trails and materials have been developed to increase the educational component of site management. Similarly, an interpretive boardwalk has been constructed on the FON's North Bruce Alvar Reserve to provide visitor access with minimal habitat damage.

Conserving Great Lakes Alvars

FON and other conservation partners have also experimented with controlled burns as a habitat restoration technique at their Stone Road Alvar Reserve. On former quarry sites on Kelley's Island and Marblehead Peninsula, the Ohio Department of Natural Resources has been experimenting successfully with the establishment of lakeside daisy (*Hymenoxys herbacea*) from transplanted seed. Site managers at Misery Bay on Manitoulin Island are looking at ways to control the invasive mossy stonecrop (*Sedum acre*). On the Wikwemikong Unceded First Nation, efforts are underway to deflect human use, including ATVs, from the Tamarack Harbour alvar site.

7. Raising awareness and understanding

An important part of the International Alvar Conservation Initiative has been raising awareness of the value and vulnerability of alvar habitats at various levels. This has included information oriented to the general public in magazines such as *Seasons* and *Wildflower*, and in television, radio, and print media. A general booklet and poster are also being produced to aid in promoting awareness among the general public and related audiences such as local governments (see Chapter 7).

Another important audience, consisting of conservation practitioners in government, conservation groups, and academic institutions, is being addressed through this report, the Ontario alvar theme study, and state summary reports for New York, Ohio, and Michigan. In addition, a series of journal articles has been published, as listed in Chapter 7, and additional articles are anticipated from work sponsored through this Initiative or independently. Alvar-related presentations have been made at the Natural Areas 1998 Conference and other forums, and the Tobermory Alvar Workshop also served to significantly raise awareness of alvar issues.

Conserving Great Lakes Alvars

5.4 Priority Actions for Alvar Conservation

Alvar habitats across the Great Lakes basin are at risk. It is clear that the scope and extent of current conservation activities will not be sufficient to protect all, or even most, of the high-priority alvar sites from ongoing threats. To address this gap, four priority actions for the conservation of alvar habitats are proposed.

Priority Action 1: Continue conservation leadership

The International Alvar Conservation Initiative has been effective in creating major increases in awareness and support for protection of alvars, but only the beginning stages of on-the-ground progress towards their actual conservation have been achieved. Ongoing efforts are needed to build on the results of the past four years and to maintain momentum to secure key sites and manage them appropriately. Strong mechanisms must be in place to respond effectively when future opportunities arise or to help create opportunities at important alvar sites.

The nature of this ongoing leadership can be informed by drawing on the most successful past aspects of the Alvar Initiative. Since learning more about alvar ecosystems and threats is so vital, keeping the learning network vibrant will be essential. The linking of disparate parties to jointly support protection projects is also vital, particularly to transcend agency or jurisdictional boundaries. The success of the Alvar Initiative in forging partnerships and joint projects without creating new institutions could be a good model. As well, in the face of limited resources and competing demands, continued innovation and flexibility in achieving conservation goals will be necessary.

However, if further progress in conserving alvar habitats is to continue, there is a clear need for ongoing leadership – for one or two organizations who are committed to taking the central responsibility for making things happen. Fortunately, several organizations are well placed to undertake that role and to encourage others to develop or maintain their involvement in alvar conservation:

- *The Great Lakes Program of The Nature Conservancy should seek the necessary support to continue developing, implementing and assisting others with protection projects for high-priority alvar sites, and should incorporate alvar sites as an important component of its ecoregional protection efforts.*

Conserving Great Lakes Alvars

- *The NCC, and TNC's Canadian Conservation Partnership Program and Great Lakes Program, should consider alvar sites within the Great Lakes region as a priority for collaborative, cross-border conservation.*
- *The Federation of Ontario Naturalists should continue its leadership role on alvar conservation in Ontario through its nature reserves system, through encouragement of protection projects by the NCC, local land trusts, and nature clubs, and through advocacy of protective planning policies by the Province and municipalities.*
- *A joint alvar conservation steering committee should be established involving TNC, NCC, FON, and any other agencies or organizations directly involved in alvar conservation projects, with responsibility to achieve the following:*
 - *jointly fund, select, and oversee a contracted part-time Alvar Specialist, whose primary duties would include initiating, promoting, and coordinating alvar protection, planning, and research projects; raising awareness of alvar significance and threats; coordinating information exchanges about alvars among organizations and interested individuals; and producing a twice-annual electronic newsletter sent by email to members of the Alvar Working Group and any other interested subscribers to provide information about new research findings, conservation projects, and alvar management strategies.*
 - *monitor conservation activities related to alvar habitats within the U.S. and Canada, and periodically report on progress through presentations to appropriate conferences (such as SOLEC or the Latornell Symposium) or through brief biennial update reports.*

Priority Action 2: Develop action plans for high- priority sites

A key next step will be to develop action plans for the protection of alvar sites with a high protection urgency. There are several examples of alvar site conservation plans that can be used as models. The site conservation plan for Chaumont Barrens, available from the Central and Northern New York (C/WNY) chapter of The Nature Conservancy, is one good example. On the Carden Plain, a conservation strategy for alvars and other habitats has been developed by the Couchiching Conservancy. A joint initiative on Manitoulin Island among TNC, FON, NCC, and OMNR is pursuing the acquisition and protection of a number of alvar sites on the Island.

Even though many organizations and agencies may be involved with the development and implementation of action plans, a recognized lead organization for each site, or cluster of sites, is vital. For some areas, this is already well established – the Couchiching Conservancy has taken the lead for the Carden plain, the C/W NY chapter of TNC for the cluster of sites east

Conserving Great Lakes Alvars

of Lake Ontario, the Michigan TNC chapter for Maxton Plains and nearby alvars, the Ohio Department of Natural Resources for the Ohio cluster, and the FON for alvar sites on the Bruce Peninsula and Pelee Island. But for other alvar clusters such as Napanee Plains, local leadership is either uncertain or lacking at this point.

It is important to recognize that action plans at this level involve more than ecological considerations – they must also consider social, community, and economic issues. Often, new ways must be found to integrate local concerns or traditional uses into protection strategies, so that local support will be developed and sustained. Similarly, protection does not always equate to outright ownership of alvar sites. Handshake agreements and education activities with private landowners, conservation easements, or a wide range of other techniques may be appropriate.

Strengthening the protection of priority alvar sites on the ground through action plans can be achieved by the following actions:

- *TNC, FON, and NCC should work with state chapters, land trusts, and government agencies to identify a local lead conservation organization for each high-priority alvar site, with special emphasis on multiple-value sites with high protection urgency.*
- *TNC, FON, and NCC should also look for opportunities to create major joint projects at the international or regional scale, similar to the existing Manitoulin Island project. These joint projects could entail shared planning and fundraising activities.*
- *Locally-based programs to carry out landowner contact with private owners of alvar sites should be encouraged and supported wherever possible, both to assist in educating landowners about the ecological values of alvars and to identify properties at risk.*
- *Members of the Alvar Working Group and other interested professionals should be requested to make themselves available on a voluntary basis to provide advice and assistance to local lead organizations developing alvar conservation action plans.*
- *The Province of Ontario and municipalities should be encouraged to establish regional aggregate advisory committees where potential quarrying and alvar habitats conflict, involving aggregate producers and conservationists. In addition, the Province should designate Manitoulin Island under the Aggregate Resources Act without further delay to ensure that ecological concerns are considered in quarry applications.*
- *The Ontario Ministry of Natural Resources should be urged to incorporate the results of the Ontario Alvar Theme Study into their ANSI system and to participate strongly in strategic acquisition and restoration of alvar sites.*
- *State and provincial Heritage Programs should establish S-ranks for the alvar communities outlined in this report; encourage further inventory, analysis, and research*

Conserving Great Lakes Alvars

related to alvar sites; and ensure that the resulting data are accessible for use as soon as possible.

- *TNC, NCC, and FON should increase the capacity of local partner organizations to participate effectively in alvar conservation by providing training on site conservation planning methodology, using existing plans as models and implementing site conservation plans at specific high-priority sites in conjunction with local partners as pilot projects.*

Priority Action 3: Broaden and strengthen support

An important part of the Alvar Initiative has been the creation of stronger links between the science of alvars and public education. These links not only relate to broader understanding of the ecology of alvars, but also they help to connect regional thinking with local activities by showing that locally common alvar types may be very rare at a broader scale.

Building support involves more than a single strand of effort since there are several audiences to be considered and different channels to each. One key audience is private landowners, as noted above. Another is the Ontario native community, because significant alvar sites such as Cape Croker, Tamarack Harbour, and Fishing Islands are on First Nations lands, and others such as Clapperton Island are part of active native land claims. A third is conservation practitioners, both inside and outside government agencies, who can do much to aid alvar conservation if they are aware of their value. Finally, the general public is an important audience to build support for alvar conservation.

The following steps will help to broaden and strengthen support for alvar conservation.

- *The glossy booklet and poster developed as part of the Alvar Initiative should be distributed broadly to naturalist and community groups, municipalities, and schools in areas around alvar sites.*
- *Information on specific alvar sites and their significance should be provided to local jurisdictions and public land management agencies that have alvars within their jurisdictions.*
- *FON, TNC state chapters, nature clubs, and private operators should be encouraged to conduct low-impact tours of alvar sites to increase public appreciation of their value and to demonstrate their potential as ecotourism assets to local communities.*
- *Community-based conservation programs to develop local interest and support in alvar and associated habitats should be continued and expanded wherever possible.*

Conserving Great Lakes Alvars

Manitoulin Island and the Napanee Plain should be considered priorities for additional work in this important activity.

- *Ongoing efforts should be made to involve First Nation communities in alvar conservation, particularly in the Bruce Peninsula and Manitoulin Island areas.*
- *TNC's Great Lakes Program and FON should seek out opportunities to present a synopsis of the International Alvar Conservation Initiative's findings to key audiences within their organizations, within other conservation organizations, and within relevant government agencies.*
- *Continued networking and collaboration among alvar researchers and conservation practitioners should be encouraged, including site visits, periodic gatherings, and involvement in an electronic newsletter.*

Priority Action 4: Fill knowledge and research gaps

The past four years of effort has enormously improved our understanding of alvar habitats and their distribution, but there is much more to learn.

Ongoing research should be encouraged by conservation organizations and agencies, academic institutions, and interested individuals. Among the most important topics for further research are the following:

- *Additional information on what on-site activities are compatible with alvar conservation, particularly with respect to acceptable levels of cattle grazing and deer browsing*
- *Experimentation with and research on the role of fire as a management tool for alvars*
- *Research on the effects of surrounding land use near alvars and how negative effects can be mitigated*
- *More effective management techniques for the control of aggressive non-native species within alvar habitats*
- *Experimentation with restoration of degraded alvar habitats, either through active management or natural succession*
- *Improved methods to monitor and learn from management techniques as they are applied*
- *Predictive modeling techniques to assess future threats and clarify the relative vulnerability of alvar sites*

Conserving Great Lakes Alvars

- *Documentation of the significance of alvar-associated habitats, especially including Great Lakes limestone bedrock shores, bur oak limestone savannas, and dolomite prairies, as well as the rich limestone woodlands often found adjacent to alvars*
- *Determine the relationship between Great Lakes alvars and associated habitats to similar community types outside the Great Lakes region*
- *Ongoing inventory and field investigation of alvar habitats, especially on known historic sites, in shoreline and riverine settings, in the Province of Quebec, and involving lesser-known target groups such as invertebrates and nonvascular plants.*

6.0 Evaluation of the Collaborative Process

6.1 Outline of the Process Steps

Over a span of approximately four years, the Alvar Initiative involved a series of steps:

"Conserving Great Lakes Alvars" Proposal Development

A group of about 20 people from U.S. and Canadian organizations came together under the leadership of TNC's Great Lakes Program to identify priority threats and information gaps, reach consensus on an overall approach to address them, and guide the preparation of a proposal.

Work Plan and Funding Submission

TNC's Great Lakes Program developed a detailed proposal with review and input from the initial group, including a work plan and proposed schedule, and secured core funding through the Great Lakes Protection Fund (GLPF).

Enlisting Collaborators

Potential collaborators were identified and contacted, with "word-of-mouth" and suggestions from involved organizations being used to identify interested individuals. Collaborators were asked to sign an agreement (as required by the GLPF) that they would participate through in-kind work or matching funding.

First Annual Gathering

The first meeting of collaborators in April 1995 developed field forms for vegetation community and rare plant inventories, established research

Conserving Great Lakes Alvars

hypotheses and initial field projects on alvar ecology, set targets for rare animal groups and ecological processes to be studied, and allocated initial funding to specific projects. Considerable advance work and follow-up by TNC's Great Lakes Program and other participants also took place.

Second Annual Gathering

The second annual gathering in March 1996 featured reports on progress and findings to date, identification of priority sites for further inventory work, refinement of research hypotheses and projects, and initial discussions of the documentation needed to establish conservation priorities.

Third Annual Gathering

The June 1997 gathering also provided updates on progress and findings, but divided into two sub-groups for most of its discussions. One group further reviewed and refined the alvar community classification system and discussed criteria and approaches for site prioritization. The other group developed communication strategies for target audiences and started planning for the Alvar Workshop, a task which was carried on over the next year by a small planning group.

Alvar Workshop

The Tobermory Alvar Workshop, held in June 1998, was designed to communicate the Initiative's findings on alvar distribution, community types, and ecology to a broader audience. This audience included key conservation organization and government agency staff, interested landowners, and other stakeholders. As well, conservation case studies and perspectives on alvar conservation issues were presented. Participants were also engaged in structured discussions on conservation priorities and emerging themes to help provide direction for the ongoing analysis and the final report.

Reporting of Results

The last six months of the Alvar Initiative focused on finalizing and bringing together the results of a broad range of inventory and research work and ensuring that these results were communicated to the appropriate audiences. These include the conservation practitioner audience, to be addressed through this final technical report, state summaries and the Ontario alvar theme study, and published scientific articles. A broader audience of landowners and interested public are being addressed through a glossy alvar booklet, a poster, and various magazine and media articles.

6.2 Key Ingredients for Success

Conserving Great Lakes Alvars

Managing a project of such geographic scope and institutional complexity presents some very real challenges. Because of the number of organizations and individuals involved, decision-making can at times appear untidy, and there is a real risk of overlap or gaps in project activities. On the other hand, the opportunity for individual participants to learn from each other and feel they are an important part of something larger and international in scope is a major benefit.

Because the International Alvar Conservation Initiative could serve as a model for those working towards coordination of other regional conservation efforts, we offer the following observations on the “lessons learned” from this experience, based on observations by project coordinators Sue Crispin and Ron Reid:

- There appears to be tremendous potential for support of truly international, regional-scale work that has clear objectives and is well planned.
- The establishment of a core project fund of significant size, as provided for the Alvar Initiative by the Great Lakes Protection Fund and later the C.S. Mott Foundation, provides strong leverage for the commitment of additional matching funding from other sources, as well as “in-kind” commitment of staff time and resources from a wide range of agencies and organizations.
- New money is essential to support new work at this scale. Many great project ideas fail because the responsibility for carrying them forward rests with people who, though enthusiastic and capable, are already over-committed and have no additional resources to help meet new demands.
- The diversity of people involved – scientists and non-scientists, professionals and volunteers, government and non-government – adds enormously to the strength of the project. This diverse network offers flexibility in overcoming bureaucratic and jurisdictional challenges and helps make the project “real” to landowners and local agencies.
- Coordination and support (financial, communications, meetings, etc.) of large-scale, multi-partner efforts requires a major time investment – in the case of this project, 30-50% of two professional staff people’s time as well as some administrative support (10-20% of another staff person). Without dedicated coordination and support, too much responsibility for the critical details of project management and

Conserving Great Lakes Alvars

coordination falls back on participants, who need to be contributing expertise rather than administrative services.

- The ease of group decision-making is inversely proportional to group size. It is virtually impossible to achieve broad consensus on all of the many decisions that need to be made in a project such as this, due to both the challenge of communication among so many actors and the wide variety of individual perspectives and opinions. What works best is to achieve agreement at meetings on the key objectives and operating principles and then confer decision-making authority on various issues to identified lead actors who consult with group members when appropriate and feasible. For some specific tasks, such as planning the Alvar Workshop, small task groups worked effectively.
- Despite the difficulty of decision-making in large groups, the annual gatherings of collaborators were vital to the process, providing opportunities for progress updates, stimulating debates on contentious issues, and developing new approaches to problems. E-mail communication and occasional telephone conference calls supplement these gatherings, but cannot replace face-to-face contact.
- Clear contracts or letters of agreement for individual project activities are essential, setting out the products to be delivered, the time-frame, financial arrangements, and any other expectations. While the Alvar Initiative followed this practice for individual researchers and contractors, it did not always do so with other organizations, sometimes leading to confusion or misunderstandings later in the process.
- While it is important to be crystal clear about project objectives and stick to them, it is also essential to remain flexible about the means of achieving them. This allows room for creativity, different points of view, and opportunities for learning during the process. It also allows for flexibility in responding to new opportunities, such as additional resources provided during the course of the project.
- There will be some disagreements (especially about methods and details) that are simply unresolvable and must be accepted, but everyone must feel they have at least had a chance to be heard.
- As is always true in life, money complicates things. Access to new money will generate healthy competition among ideas and their proponents, but can also place collaborators who are independent researchers or contractors in an awkward position with respect to participating in group decisions on priorities and funding allocations.

Conserving Great Lakes Alvars

Disagreements in this area are the most difficult to manage (open and frank discussion can even be a challenge), and may ultimately fall to the project managers to resolve.

- It is vital to start thinking early in the project about how results will be communicated effectively to key audiences. A strong communications strategy can help shape the analysis and reporting stages of the project in the most productive directions.
- One of the benefits of a bi-national approach is the added credibility and stature it confers to local organizations who are involved as collaborators and to their local sites. Being part of such an international approach brings access to new information and ideas, contact with people working on similar challenges in other areas, and local recognition that you are part of something important. This can serve as a source of new energy and credibility for local groups in their advocacy and other protection efforts.

6.3 Adapting the Collaborative Process for Other Ecosystem Types

The Alvar Initiative project manager was asked to present information on the collaborative process of a conference on Great Lakes islands as one potential ecosystem that might benefit from a similar approach. Within the Great Lakes region, other bi-national resources that might merit similar attention could include special ecosystem types often associated with Great Lakes shorelines, such as sand beaches and dune systems, bedrock and cobble beaches, unconsolidated shore bluffs, limestone cliffs and talus slopes, lakeplain prairies, sand barrens, and communities containing unusual species, such as arctic-alpine disjuncts and Atlantic coastal plain disjuncts (Reid and Holland, 1997).

Specialized or sparsely distributed wetland types might also be of interest, such as fens or bogs south of the Canadian Shield or Great Lakes coastal marshes.

Almost any ecosystem type could benefit from a collaborative approach if the following criteria are met:

- high biological significance
- identified threats
- inadequate current protection
- core of knowledgeable and committed collaborators

Conserving Great Lakes Alvars

- clear information impediments to effective conservation action
- identified conservation actors interested in using results
- good potential for a willing lead funder

The initiation of a collaborative approach for any of these or other ecosystem types will be dependent on the presence of a sponsoring organization willing to take the lead in bringing together potential participants and coordinating the development and presentation of a proposal and work plan on their behalf. Our experience with the Alvar Initiative suggests that the benefits and satisfaction of working across borders to protect significant elements of biodiversity greatly outweighs the complexity of the challenge.

Conserving Great Lakes Alvars

7.0 Sources of More Detailed Information

This report is intended to provide only an overview of the findings of the International Alvar Conservation Initiative. For those who want more detailed information, a series of sources are listed below.

Detailed information on specific sites

A series of site summary documents have been prepared in various formats at the state/provincial level. These reports describe alvar characteristics and distribution for each jurisdiction and provide a summary description of individual sites and features of significance.

New York State:

Alvar Conservation: Protecting Eastern North America's Most Endangered Ecosystem: Site Summary Data for New York. By Bruce Gilman. Prepared for The Nature Conservancy C/W NY Chapter. 1998. Available from: The Nature Conservancy, Eastern Lake Ontario Project Office, 7 South Jefferson Street, Suite 3, Pulaski, NY 13142.

Ohio:

Alvar Landforms and Plant Communities in Ohio: Overview and Site Summaries. By Allison Cusick. Ohio Department of Natural Resources. 1998. Available from: Allison Cusick, Division of Natural Areas and Preserves, Ohio Department of Natural Resources, Fountain Square, Bldg F, Columbus, OH 43224.

Michigan:

Alvars of Michigan. By YuMan Lee and Lyn Scrimger. Michigan Natural Features Inventory. 1998. Available from: Michigan Natural Features Inventory, 8th Floor Mason Bldg, P.O. Box 30444, Lansing, MI 48909.

Ontario:

Significant Alvar Natural Heritage Areas in the Ontario Great Lakes Region. By Vivian R. Brownell. Prepared for Federation of Ontario Naturalists. In press. Available from: Federation of Ontario Naturalists, 355 Lesmill Road, Don Mills, Ontario, M3B 2W8.

Copies of the field data sheets on community composition for alvars studied during this project, including data for plots and species lists by structural types, are on file at TNC's Great Lakes Program office in Chicago. As well, occurrence data on species and communities is compiled in the Biological and Conservation Database for each state/province, and can be requested through:

New York Natural Heritage Program: Kathy Schneider
Phone: 518-783-3937 E-mail: kjschnei@gw.dec.state.ny.us

Ohio Department of Natural Resources: Allison Cusick
Phone 614-265-6471 E-mail: Awcusick@aol.com

Conserving Great Lakes Alvars

Michigan Natural Features Inventory: Lyn Scrimger
Phone: 517-373-1552 E-mail: scrimgel@state.mi.us

Wisconsin Natural Heritage Program: Eric Epstein
Phone: 608-267-5038 E-mail: epstee@dnr.state.wi.us

Ontario Natural Heritage Information Centre: Jarmo Jalava
Phone: 705-755-2167 E-mail: jalavaja@epo.gov.on.ca

Information on research findings

A number of journal articles, theses, and unpublished papers can be consulted for detailed results from studies associated with or supported by the International Alvar Conservation Initiative:

Bouchard, P., H. Goulet and T.A. Wheeler. 1998. Phenology and habitat preferences of three species of ground beetles (Coleoptera: Carabidae) associated with alvar habitats in southern Ontario. *Proceedings of the Entomological Society of Ontario*. (In press).

Bouchard, Patrice. 1998. Insect diversity in alvars of southern Ontario. Prepared for Federation of Ontario Naturalists, Toronto. 87 pp.

Bouchard, Patrice, 1997. Insect Diversity in Alvars Habitats, Manitoulin Island, Ontario. Prepared for Great Lakes Program, The Nature Conservancy and Ontario Natural Heritage Information Centre. 28 pp. and appendices.

Catling, Paul M. and Vivian R. Brownell 1998. Importance of fire in the maintenance of distinctive, high diversity plant communities on alvars – evidence from the Burnt Lands, eastern Ontario. *Canadian Field-Naturalist* 112: in press.

Feeney, T.P. 1997. The Geomorphic Evolution of Limestone Pavements and Alvar Grasslands in Northwestern New York State, USA. Unpublished Ph.D. dissertation, University of Georgia, Athens, GA. 311 pp.

Feeney, Thomas P. 1996. The Role of Grikes in Limestone Pavement Formation in Northern New York State, USA. In *Karren Landforms*, eds. J.J. Fornos and A. Gines. Universitat de les Illes Balears: Palma de Mallorca, Spain. Aug. 1996. pp. 53-62.

Gilman, Bruce A. 1995. Vegetation of Limerick Cedars: Pattern and Process in Alvar Communities. Unpublished dissertation, SUNY College of Environmental Science and Forestry, Syracuse, NY. 322 pp.

Goodban, A.G. 1995. Alvar Vegetation on the Flamborough Plain: Ecological Features, Planning Considerations and Conservation Recommendations. Major Paper. Faculty of Environmental Studies, York University, North York, Ontario. 88 pp. + appendices.

Grimm, F. Wayne. 1995. Molluscs of the Alvar Arc and the Niagara Cuesta Uplands and Barren Zones. *Proceedings of the Leading Edge '95 Conference*, Collingwood, Ontario. Ontario Ministry of Environment and Energy, Toronto.

Conserving Great Lakes Alvars

Reschke, Carol. 1995. Biological and hydrological monitoring at the Chaumont Barrens Preserve. Unpublished report for The Nature Conservancy's Rodney Johnson Grants Program, Grant #R93NY01. 65 pp., + 4 appendices. Available from The Nature Conservancy, Arlington, VA.

Schaefer, C.A. 1996. Plant community structure and environmental conditions of alvars on the Bruce Peninsula, Ontario, Canada. M.Sc. Thesis. University of Guelph, Ont. 156 pp.

Schaefer, C.A. and D.W. Larson. 1997. Vegetation, environmental characteristics and ideas on the maintenance of alvars on the Bruce Peninsula, Canada. *Journal of Vegetation Science* 8:797-810.

Stanton, E.J. 1998. Evaluating the completeness of a macrolepidoptera inventory using species abundance distribution: three case studies in New York State. M.S. thesis, SUNY Coll. Environ. Sci. and Forestry, Syracuse, NY. 67 pp + appendix.

Stanton, Edward J. 1997. Inventory of the macrolepidoptera on alvars of Jefferson County, New York. Prepared for The Nature Conservancy C/W NY Chapter and New York Heritage Program. 19 pp. and appendices.

Additional unpublished reports relating to Alvar Initiative results are included in the list of references cited.

Information suitable for a general audience

A full-color booklet, titled *Great Lakes Alvars*, and an associated color poster are being produced by the Federation of Ontario Naturalists and are available from their Toronto office at the address listed above.

Several alvar booklets oriented toward private landowners within local areas have been produced in association with the Alvar Initiative:

Carden Plain Habitat Conservation, available from The Couchiching Conservancy, Carden Alvar Project, Box 330, Washago, Ontario, L0K 2B0.

Manitoulin's Flat Rock Country: A Landowners Guide to a Special Habitat, available from Federation of Ontario Naturalists, 355 Lesmill Road, Don Mills, Ontario, M3B 2W8.

The Burnt Lands Alvar Habitat Conservation, *The Napanee Plain Alvar Habitat Conservation*, and *Bruce Peninsula Alvar Habitat Conservation*, all available from Ontario Natural Heritage Information Centre, Ministry of Natural Resources, Box 7000, Peterborough, Ontario, K9J 8M5.

Several magazine articles oriented towards a general audience have also been published in association with the Alvar Initiative, including:

The One Conservancy, newsletter, May 18, 1995
"Alvar Grasslands Protection Effort Underway"

Cuesta, the Niagara Escapment Magazine, 1995
"Nature's Rock Gardens" by Claudia Schaefer

Mott Exchange, newsletter of the C.S. Mott Foundation, Summer-fall 1995

Conserving Great Lakes Alvars

"Why Should We Save an Alvar?" by Richards

Newsletter, TNC - NYRO, Fall 1995

"Walking in a Glacier's Path"

Katharine Ordway Associates UPDATE, TNC newsletter, 1995

"Diving into the Great Lakes"

NHIC Newsletter, Fall 1995

"International Alvar Conservation Initiative" by Wasyl Bakowsky

Ohio Division of Natural Areas and Preserves Newsletter, April-June 1996

"Alvars in Ohio" by Allison Cusick

Seasons, Autumn 1996

"Habitat for the Hardy" by Ron Reid

Wildflower, magazine, Summer 1996

"The Survivors" by Claudia Schaefer

"Grassland Communities on Manitoulin Island, Ontario" by John Morton

"Stone Prairies" by Bruce Gilman

North Coast Newsletter, Ohio Lake Erie Commission, August, 1996

"Kelleys Island North Pond, Alvar to be Dedicated as State Nature Preserve"

Great Lakes Habitat Watch #36, Great Lakes United, October 21, 1996

"Alvar Conservation"

Canadian Wildlife, August 1998

"When the going gets tough" by Patrice Bouchard

Biosphere, Aout 1998

"Quand la vie est dure" by Patrice Bouchard

The One Conservancy, TNC newsletter, August 1998

"International Workshop to Protect Globally Rare Great Lakes Alvar Ecosystems"

The Nature Conservancy, Central & Western New York Chapter, newsletter, fall 1998

"Alvar: Mother Nature's Rock Garden"

Conserving Great Lakes Alvars

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Conserving Great Lakes Alvars

Conserving Great Lakes Alvars

References Cited

- Albert, D.A., P.J. Comer, R.A. Corner, D.L. Cuthrell, M.R. Penskar and M.L. Rabe. 1997. Bedrock communities on Michigan's Great Lakes shoreline. Report to Michigan Department of Environmental Quality. 215 pp.
- Albert, D.A., P.J. Comer, R.A. Corner, D.L. Cuthrell, M.R. Penskar and M.L. Rabe. 1995. Bedrock shoreline biological survey of the Niagaran Escarpment in Michigan's Upper Peninsula: Mackinac County to Delta County. Report to Michigan Department of Environmental Quality, Land and Water Management Division. 51 pp.
- Albert, D.A., P. Comer, D. Cuthrell, M. Penskar, M. Rabe and C. Reschke. 1994. Bedrock shoreline surveys of the Keweenaw Peninsula and Drummond Island in Michigan's Upper Peninsula. Michigan Natural Features Inventory. Lansing, MI 48909-7944. 94pp.
- Alvar Working Group. 1996. Preliminary research hypotheses: browsing and grazing. March 1996 unpublished meeting notes.
- Alvar Working Group. 1995. Definition of alvar for the purposes of the International Alvar Conservation Initiative. Unpublished.
- Anderson, M., P. Bourgeron, M. T. Bryer, R. Crawford, L. Engelking, D. Faber-Langendoen, M. Gallyoun, K. Goodin, D. H. Grossman, S. Landaal, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, L. Sneddon, and A. S. Weakley. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume II. The National Vegetation Classification System: list of types. The Nature Conservancy, Arlington, Virginia, USA.
- Baskin, J.M and C.C. Baskin 1985. Life cycle ecology of annual plant species of cedar glades of south-eastern United States. In: White, J. (editor). The population structure of vegetation. Junk Publishers. Dordrecht. Pp. 371-398.
- Bazely, D. R. et al. 1997. Interactions between deer and vegetation in southern Ontario, Canada: Monitoring and restoration of overgrazed plant communities in Pinery and Rondeau Provincial Park. Report 2 to the Southern Region Science & Technology Transfer Unit. Ontario Ministry of Natural Resources.
- Belcher, J. W. 1992. The ecology of alvar vegetation in Canada: description, patterns, competition. M.Sc. Thesis. University of Ottawa, Ontario.
- Belcher, J. W., Keddy, P. A., and Catling, P. A. 1992. Alvar vegetation in Canada: a multivariate description at two scales. *Can. J. Bot.* 70:1279-1291.
- Bell, J., 1870, List of plants of the Manitoulin Islands, Lake Huron. Geological Survey of Canada Report for 1867-1869.
- Bengtsson, K., H.C. Prentice, E. Rosen, R. Moberg and E. Sjogren 1988. The dry alvar grasslands of Oland: ecological amplitudes of plant species in relation to vegetation composition. *Acta Phytogeographica Suecica* 76:21-46.
- Bertrand, R. 1996. Hydrological Monitoring of the Chaumont Barrens: Summer 1996. Unpublished report to The Nature Conservancy.

Conserving Great Lakes Alvars

- Beschel, R. E. 1965. Comments on the vegetation of the Kingston region. *Bluebill* 12: 32-36.
- Bouchard, Patrice. 1998. Insect Diversity in Alvars of Southern Ontario. Report presented to the Federation of Ontario Naturalists, Toronto. 87 pp.
- Bouchard, Patrice 1997. Insect Diversity in Alvars Habitats, Manitoulin Island, Ontario. Report presented to The Nature Conservancy Great Lakes Program and Ontario Natural Heritage Information Centre. 28 pp. + appendices.
- Brownell, Vivian R. 1998. Significant alvar natural heritage areas in the Ontario Great Lakes region: a preliminary discussion paper. Prepared for Federation of Ontario Naturalists, Toronto. 54 pp.
- Brunton, Daniel F. 1988. The Clay Bank Alvar: An Important Natural Area in the Ottawa Valley. *Trail and Landscape*. Vol. 22: No. 2: 53-65.
- Brunton, D.F. 1986. A life science inventory of the Burnt Lands. Ontario Ministry of Natural Resources. 118 pp. + maps.
- Catling, Paul M. 1995. The extent of confinement of vascular plants to alvars in southern Ontario. *Canadian Field-Naturalist* 109(2): 172-181.
- Catling, Paul M. and Vivian R. Brownell. 1998. Importance of fire in the maintenance of distinctive, high diversity plant communities on alvars – evidence from the Burnt Lands, eastern Ontario. *Canadian Field-Naturalist* 112: in press.
- Catling, Paul M. and Vivian R. Brownell. 1995. A review of the alvars of the Great Lakes region: distribution, floristic composition, biogeography and protection. *Canadian Field-Naturalist* 109(2): 143-171.
- Catling, P.M., A. A. Reznicek, and W. J. Crins. 1993. *Carex juniperorum* (Cyperaceae), a new species from northeastern North America, with a key to *Carex* sect. *Phyllostachys*. *Systematic Botany* 18(3): 496-501.
- Catling, P. M., J. E. Cruise, K. L. McIntosh, and S. M. McKay. 1975. Alvar vegetation in southern Ontario. *Ontario Field Biologist* 29(2): 1-25.
- Chabot, A. A. 1994. Habitat selection and reproductive biology of the Loggerhead Shrike in eastern Ontario and Quebec. Faculty of Science, Macdonald College, McGill University, Montreal, P.Q.
- Comer, P. J., D. L. Cuthrell, D. A. Albert, and M. R. Penskar. 1997. Natural community abstract for limestone/dolostone pavement lakeshore. Michigan Natural Features Inventory, Lansing, MI. 4 pp.
- Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Corner & D.W. Schuen (map interpretation); T.R. Leibfreid, M.B. Austin, C.J. DeLain, L. Prange-Gregory, L.J. Scrimger, K.M. Korroch, & J.G. Spitzley (digital map production). 1995. Michigan's presettlement vegetation, as interpreted from the General Land Office Surveys 1816-1856. Michigan Natural Features Inventory, Lansing, MI. digital map.
- Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Corner and D.W. Schuen. 1995. Michigan's native landscape, as interpreted from the General Land Office Surveys 1816-1856. Report to the U.S.E.P.A. Water Division and the

Conserving Great Lakes Alvars

- Wildlife Division, Michigan Department of Natural Resources. Michigan Natural Features Inventory, Lansing, MI. 78 pp.
- Coulianos, C.C. and E. Sylven. 1983. The distinctive character of the Great Alvar (Oland, Sweden) from an entomological point of view. *Entomologisk Tidskrift*. 104:213-234.
- Cronquist, A., 1991, *Manual of Vascular Plants of Northeastern United States and Adjacent Canada* 2nd ed., New York Botanical Garden, N.Y.
- Curtis, J.T. 1959. *The vegetation of Wisconsin*. Madison: The University of Wisconsin Press.
- D'Arcy, Gordon, and John Hayward 1997. *The Natural History of The Burren*. Immel Press, London, England. 168 pp.
- Dore, W.G. and McNeill, J., 1980, *Grasses of Ontario*, Monograph No. 26., Agriculture Canada, Ottawa.
- Dunn, Erica H. and C.M. Downes. 1998. Monitoring Canada's songbirds: status and results. *Bird Trends*. No. 6, Spring 1998. Canadian Wildlife Service, Ottawa.
- Erickson, R.O., L.G. Brenner and J. Wraight. 1942. Dolomitic glades of east-central Missouri. *Annals of the Missouri Botanical Garden* 29:89-101.
- Feeney, T.P. 1997. *The Geomorphic Evolution of Limestone Pavements and Alvar Grasslands in Northwestern New York State, USA*. Unpublished Ph.D. dissertation, University of Georgia, Athens GA. 311 p.
- Feeney, T.P. 1996. *The Source of Seasonal Flood Waters in Alvar Grasslands: Chaumont Barrens, New York State*. Unpublished report to The Nature Conservancy.
- Gilman, Bruce. 1997a. *An Addendum to Summary of Original Land Survey Data for Northern New York Alvar Sites*. Unpublished report for The Nature Conservancy's Alvar Conservation Initiative.
- Gilman, Bruce. 1997b. *Recent Fire History Data for the Perch River Barrens Alvar Site*. Unpublished report for The Nature Conservancy's Alvar Conservation Initiative.
- Gilman, Bruce. 1996a. *Summary of Original Land Survey Data for Northern New York Alvar Sites*. Unpublished report for The Nature Conservancy's Alvar Conservation Initiative.
- Gilman, Bruce. 1996b. *A Search for Potentially Ancient Conifer Trees in Northern New York Alvar Sites*. Unpublished report for The Nature Conservancy's Alvar Conservation Initiative.
- Gilman, Bruce A. 1995. *Vegetation of Limerick Cedars: Pattern and Process in Alvar Communities*. Unpublished dissertation, SUNY College of Environmental Science and Forestry, Syracuse, NY. 322 pp.
- Goodban, Anthony G. 1995. *Alvar vegetation on the Flamborough Plain: ecological features, planning issues and conservation recommendations*. MS thesis, York University, North York, Ontario.
- Grimm, F. Wayne. 1995. *Molluscs of the Alvar Arc and the Niagara Cuesta Uplands and Barren Zones*. Proceedings of the Leading Edge '95 Conference, Collingwood, Ontario. Ontario Ministry of Environment and Energy.

Conserving Great Lakes Alvars

- Grossman, D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume I. The National Vegetation Classification System: development, status, and applications. The Nature Conservancy, Arlington, Virginia, USA.
- Hamilton, K.G.A. 1996. Native leafhoppers at US alvar sites. Unpublished report submitted to The Nature Conservancy Great Lakes Program. 3 pp.
- Hamilton, K.G.A. 1995. Evaluation of leafhoppers and their relatives (Insecta: Homoptera: Auchenorrhyncha) as indicators of prairie reserve quality. Proceedings of the 14th North American Prairie Conference. Preney Print and Litho Inc. Windsor. Pp. 211-226.
- Hamilton, K.G.A. 1994. Leafhopper evidence for origins of Northeastern relict prairies (Insecta: Homoptera: Cicadellidae). Proceedings of the 13th North American Prairie Conference. Preney Print and Litho Inc. Windsor. Pp. 61-70.
- Hamilton, K.G.A. 1990. Grasslands of Ontario and surrounding areas. Arthropods of Canadian Grasslands Newsletter. 5:2-10.
- Johnsen, J. H. 1971. The Limestones (Middle Ordovician) of Jefferson County, New York. Map and Chart Series # 13, New York State Museum and Science Service, Albany NY.
- Jones, Judith. 1997. Report on the Fire History of the Bur Oak Alvars, Sheguiandah Township, Manitoulin Island. Unpublished report prepared for The Nature Conservancy's Alvar Conservation Initiative. December 1997. 10 pp + 4 maps.
- Jones, Judith. 1996. Report From Fieldwork on Manitoulin Island Area Alvars 1995 and 1996. Unpublished report for The Nature Conservancy's Alvar Conservation Initiative.
- Kirk, Donald A. 1992. Stone Road Alvar, Pelee Island: management of an unusual oak savannah community type in the western Lake Erie archipelago. pp 33 - 43 *in*: Spirit of the Land, Our Prairie Legacy. Proceedings of the Thirteenth North American Prairie Conference. R.G. Wickett, P.D. Lewis, A. Woodliffe, and P. Pratt, eds., Dept. of Parks and Recreation, Windsor, Ontario, Canada.
- Koh, S. and D.R. Bazely. 1994. Response of vegetation to grazing pressure by white-tailed deer *Odocoileus virginianus*. Point Pelee National Park, Internal Report.
- Koh, S and D.R. Bazely. 1992. Response of vegetation to grazing pressure by white-tailed deer *Odocoileus virginianus*. Point Pelee National Park, Internal Report.
- Koh, S. 1995. The effect of white-tailed deer *Odocoileus virginianus* on herbaceous plant species composition and cover in Rondeau Provincial Park. M.Sc. Thesis, York University, Toronto, Canada.
- Lee, H. T., W. D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig, and S. McMurray. 1998. Ecological Land Classification for Southern Ontario: First Approximation and Its Application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.
- Lougeay, R. 1994. Hydroclimatic Reconnaissance of the Chaumont Barrens. Unpublished report to The Nature Conservancy.

Conserving Great Lakes Alvars

- Lougeay, R. 1996. Rates of Desiccation: Chaumont Barrens, NY. Unpublished report to The Nature Conservancy.
- Marr, J. K. 1997. Cryptogams of an alvar on Drummond Island, Chippewa County, Michigan. Unpublished report submitted in partial fulfillment of the requirements for the Master of Science Degree. Department of Biological Sciences, Michigan Technological University, Houghton, MI
- McCune, B. and M. J. Mefford. 1997. PC-ORD. Multivariate Analysis of Ecological Data, Version 3.0. MjM Software Design, Gleneden Beach, Oregon, USA.
- McCune, B. and M. J. Mefford. 1995. PC-ORD. Multivariate Analysis of Ecological Data, Version 2.0. MjM Software Design, Gleneden Beach, Oregon, USA.
- Morton, J.K. and Venn, J. M., 1990, A Checklist of the flora of Ontario Vascular Plants, University of Waterloo, Biology Series No. 34, Waterloo, Ontario.
- Morton, J.K. and Venn, J.M., 1984, The Flora of Manitoulin Island, University of Waterloo, Biology Series, No. 28, Waterloo, Ontario.
- Pearl, D.L., S. Koh, D.R. Bazely, D.R. Voigt, M. Tang and W. Soo. 1995. Interactions between deer and vegetation in southern Ontario, Canada: Monitoring and restoration of overgrazed plant communities in Pinery and Rondeau Provincial Park. Southern Region Science & Technology Transfer Unit Technical Report. TR-010. 49 pg. Ontario. Ministry of Natural Resources.
- Reid, Ron and Karen Holland. 1997. The Land by the Lakes: Nearshore Terrestrial Ecosystems. State of the Lakes Ecosystem Conference 1996 Background Paper. U.S. Environmental Protection Agency, Chicago.
- Reschke, Carol. 1995a. Biological and hydrological monitoring at the Chaumont Barrens Preserve. Unpublished report for The Nature Conservancy's Rodney Johnson Grants Program, Grant #R93NY01. 65 p., plus 4 appendices. Copies available from The Nature Conservancy, Arlington, VA.
- Reschke, C. 1995b. Development of Research Methodologies for the International Alvar Conservation Initiative. Report for The Nature Conservancy's Rodney Johnson Grants program, Grant #R95MR01.
- Reschke, Carol. 1990a. Ecological Communities of New York State. New York Natural Heritage Program, New York State Department of Environmental Conservation, Latham, NY. 96 pp.
- Reschke, Carol. 1990b. Techniques used for the inventory of rare ecological communities in New York State. pages 102 - 105 in: Ecosystem Management: Rare Species and Significant Habitats. New York State Museum Bulletin 471, Albany, NY.
- Rosen, E. 1995. Periodic droughts and long-term dynamics of alvar grassland vegetation on Oland, Sweden. *Folia Geobotanica et Phytotoxonomica*, Praha. 30:131-140.
- Rosen, E. 1992. Vegetation development and sheep grazing in limestone grasslands of south Oland, Sweden. *Acta Phytogeographica Suecica* 72:1-104.

Conserving Great Lakes Alvars

- Rusch, Graciela. 1996. Alvar landscapes in Europe. Unpublished paper. 3 pp.
- Rusch, Graciela 1988. Reproductive regeneration in grazed and ungrazed limestone grassland communities on Oland: preliminary results. *Acta Phytogeographica Suecica* 76:113-124.
- Samuels, A. 1998. Untitled report on results of research on buckthorn (*Rhamnus cathartica*) at Chaumont Barrens Preserve. 45 pp. The Nature Conservancy, Eastern Lake Ontario Program Office, Pulaski, NY.
- Schaefer, C.A. and D.W. Larson. 1997. Vegetation, environmental characteristics and ideas on the maintenance of alvars on the Bruce Peninsula, Canada. *Journal of Vegetation Science* 8:797-810.
- Schaefer, Claudia. 1996a. The Role of Fire in Carden Township Alvars. Unpublished report for The Nature Conservancy's Alvar Conservation Initiative.
- Schaefer, Claudia. 1996b. Map of Potential Alvar Habitat in Carden Township, Victoria County, Ontario, in the Mid-1800's. Unpublished report for the Couchiching Conservancy, Orillia, Ontario.
- Schaefer, Claudia. 1996c. Comments on the Role of Fire in Bruce Peninsula Alvars. Unpublished report for Federation of Ontario Naturalists, Don Mills, Ontario.
- Schaefer, Claudia. 1996d. Map of Potential Alvar Habitat in St. Edmund's Township, Bruce County, in the Year 1855. Unpublished report for Federation of Ontario Naturalists, Don Mills, Ontario.
- Schaefer, C.A., and D.W. Larson. 1997. Vegetation, environmental characteristics and ideas on the maintenance of alvars on the Bruce Peninsula, Canada. *Journal of Vegetation Science* 8:797-810.
- Schaefer, C.A. 1996e. Plant community structure and environmental conditions of alvars on the Bruce Peninsula, Ontario, Canada. M.Sc. Thesis. University of Guelph, Ont. 156 pp.
- Slack, Nancy G., Carol Reschke, and Bruce Gilman. 1988. *Scorpidium turgescens* rediscovered in New York. *The Bryologist* 91(3):217-218.
- Smith, Ian (ed.) 1996. Assessment of species diversity in the mixed wood plain ecozone. Ecological Monitoring Assessment Project, Halifax and Ottawa. Web site www.cciw.ca/eman-temp/reports/publications/Mixedwood/intro.html
- Sneddon, Lesley (ed.) 1994. Field Form Instructions for the Description of Sites and Terrestrial, Palustrine, and Vegetated Estuarine Communities. Version 2. The Nature Conservancy, Eastern Heritage Task Force, Boston, MA.
- Stanton, E.J. 1997. Inventory of the macrolepidoptera on alvars of Jefferson County, New York. Report submitted to The Nature Conservancy and the New York Department of Environmental Conservation.
- Stephenson, S.N. 1995. Annual report to The Nature Conservancy on long-term monitoring activities on the Maxton Plains Preserve. 23 pp.

Conserving Great Lakes Alvars

Stephenson, S.N. and P.S. Herendeen. 1986. Short-term Drought Effects on The Alvar Communities of Drummond Island, Michigan. *The Michigan Botanist* 25: 16-27.

Tatnall, C. 1996. Field Observations at Chaumont Barrens: Graphic Interpretations of Information Collected by Rebecca Bertrand During Summer 1996. Unpublished report to The Nature Conservancy.

Tester, John R. 1996. Effects of fire frequency on plant species in oak savanna in east-central Minnesota. *Bulletin Torrey Botanical Club* 123(4): 304-308.

Titlyanova, A., G. Rusch and E. van der Maarel. 1988. Biomass structure of limestone grasslands on Oland in relation to grazing intensity. *Acta phytogeographica suecica* 76:125-134.

Voss, E.G., 1972, *The Michigan Flora Vol. I*, Cranbrook Institute of Science, Bloomfield Hills, Michigan.

Waller, Don, and Tom Rooney. 1998. How many deer are too many? Impacts on plant populations and the concept of carrying capacity. Presentation to 1998 Natural Areas Association Conference, Mackinac Island, MI. Program abstract.

Zander, R. H. and P. M. Eckel. *Tortula cainii*: Additional Ontario Records and Behavior in a Common Garden. *The Bryologist* 83(2):209-211.